

“Recycling of Cured Water Integrated with Bubble Deck Slab”

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Abstract - Bubble deck slab technology is an innovative construction method used to reduce the self-weight of reinforced concrete slabs without significantly affecting their structural performance. In conventional reinforced concrete slabs, a large portion of the concrete near the neutral axis does not effectively contribute to load carrying capacity. Bubble deck slabs address this issue by replacing the ineffective concrete with hollow plastic spheres placed between the reinforcement layers. This reduces the amount of concrete used in the slab and results in a lighter structural system. The main objective of this study is to investigate the behaviour and performance of bubble deck slabs in comparison with conventional solid slabs. The study focuses on parameters such as load carrying capacity, deflection behaviour, cracking pattern, and overall structural efficiency. By introducing hollow plastic balls made from recycled plastic waste, the technology also promotes environmentally friendly construction practices and helps reduce plastic pollution.

Key Words: Bubble deck, self-weight, Cured Water

1. INTRODUCTION

The construction industry is one of the largest consumers of natural resources such as water, sand, cement, and aggregates. Among these, water plays a critical role in activities like concrete mixing, curing, and cleaning. Concrete curing is an essential process that ensures the proper hydration of cement and helps achieve the required strength and durability of the structure. However, traditional curing methods require a large quantity of water, and a significant portion of this water is wasted due to runoff, evaporation, or absorption by surrounding materials. In many construction sites, this unused water is not collected or reused, which leads to excessive water wastage. With increasing concerns about water scarcity and environmental sustainability, the need to manage water efficiently in construction has become a major challenge. At the same time, conventional Reinforced Cement Concrete (RCC) slabs used in buildings are solid and require a large volume of concrete. This increases the dead load of the structure,

which results in higher material consumption, increased construction cost, and greater stress on foundations and structural elements. Additionally, the production of cement and concrete contributes significantly to carbon emissions, which negatively impacts the environment. As urbanization continues to grow rapidly, the demand for more sustainable and resource-efficient construction technologies is increasing..

2. Objectives

1. To reduce water wastage in construction sites by collecting and recycling the water used during the concrete curing process.
2. To design and implement a curing water recycling system that collects, filters, stores, and reuses unused curing water for further construction activities.
3. To reduce the dead load of the structure by using Bubble Deck slab technology, this replaces unnecessary concrete with hollow plastic balls.
4. To minimize the consumption of construction materials such as cement, aggregates, and steel by adopting efficient slab design techniques.
5. To promote sustainable and eco-friendly construction practices by conserving natural resources and reducing environmental impact in the building industry.

3. METHODOLOGY



Water Requirement Calculation The first step in the process is calculating the total water requirement for the concrete curing process. This involves estimating the amount of water needed for curing based on the size of the slab, curing duration, and construction standards. This calculation helps determine how much water can potentially be collected and recycled.

Design of Water Recycling System In this step, a water recycling system is designed to collect the unused curing water. The system includes components such as collection channels, filtration units, pipes, and storage tanks. The design ensures that the water used during curing is efficiently collected, cleaned, and stored for reuse.

Design of Collection Pipes and Storage Tank After designing the recycling system, proper piping arrangements are planned to collect excess curing water from the slab surface. Pipes direct the water to a filtration unit and then to a storage tank. The storage tank stores the filtered water so that it can be reused later for curing or other construction activities.

Design of Bubble Deck Slab In this stage, the structural design of the Bubble Deck slab is prepared. Hollow plastic balls are placed between layers of reinforcement to create voids inside the slab. This reduces the volume of concrete required and decreases the weight of the slab without affecting structural strength.

Integration of Both Systems This step involves combining the curing water recycling system with the Bubble Deck slab construction process. The recycled

water collected from the curing process is reused for further curing activities. This integration improves water management and promotes sustainable construction practices.

Analysis and Comparison The final step is analyzing the results obtained from the system. The performance of the proposed system is compared with conventional construction methods. Parameters such as water savings, reduction in concrete usage, structural efficiency, and cost benefits are evaluated to determine the effectiveness of the system.

4. Design / Calculation Method

I) Water Calculation:- Assume the total water required for curing the brickwork is 1000 liters. Initially, about 20% of water is absorbed by the bricks and around 10% is lost due to evaporation and runoff. Absorbed water = 20% of 1000 = 200 L Loss of water = 10% of 1000 = 100 L Remaining water = 1000 - (200 + 100) = 700 liters

Hence, about 70% (700 L) of curing water can be collected and reused using the recycling system.

II) Bubble Deck Slab Calculation:-

1) Weight Saving Before slab weight = 3.75 tons After slab weight = 2.5 tons Saving = 3.75 - 2.5 = 1.25 tons Percentage saving = $(1.25 / 3.75) \times 100 = 33.33\%$

2) Cost Saving Normal slab cost = ₹32,000 Bubble deck slab cost = ₹30,000 Cost saving = ₹2,000 Percentage saving = $(2000 / 32000) \times 100 = 6.25\%$

III) Estimation of Recyclable Water Not all curing water is absorbed by the concrete. A portion of it flows away and can be collected. Assuming 40% to 60% water runoff can be collected. Example: Total curing water = 560 liters If 50% is recoverable:

Recyclable Water = 560 × 0.5 = 280 liters

IV) Design of Collection System The collection system includes drainage channels and pipes placed around the slab. **Pipe Size Selection** Typical PVC pipe diameter used: • Small projects → 25 mm – 40 mm • Medium projects → 50 mm – 75 mm

Slope of pipe: Minimum slope = 1:100

V) Storage Tank Capacity Calculation The storage tank must be able to store the collected curing water. Formula: Tank Capacity = Daily Recyclable Water × Safety Factor Example: Daily recyclable water = 80 liters Safety factor = 1.5 Tank Capacity = 80 × 1.5 = 120 liters Therefore, a 120–150 liter tank is suitable.

VI) Bubble Deck Slab Design Calculation Bubble Deck slabs reduce the amount of concrete used by placing hollow plastic spheres in the neutral zone of the slab.

Typical reduction in concrete volume: 30% to 35%
Example Calculation Conventional slab thickness = 150 mm Concrete volume for slab: $\text{Volume} = \text{Area} \times \text{Thickness}$ $\text{Area} = 20 \text{ m}^2$ $\text{Thickness} = 0.15 \text{ m}$ $\text{Volume} = 20 \times 0.15 = 3 \text{ m}^3$ If 30% concrete is replaced: Concrete Saved = $3 \times 0.30 = 0.9 \text{ m}^3$ Concrete used in Bubble Deck slab: $3 - 0.9 = 2.1 \text{ m}^3$ Thus, the Bubble Deck slab reduces concrete usage and structural weight.

VII) Weight Reduction Calculation Density of reinforced concrete $\approx 2400 \text{ kg/m}^3$ Weight of conventional slab: $\text{Weight} = \text{Volume} \times \text{Density} = 3 \times 2400 = 7200 \text{ kg}$ Weight of Bubble Deck slab: $= 2.1 \times 2400 = 5040 \text{ kg}$ Weight Reduction: $7200 - 5040 = 2160 \text{ kg}$ This significantly reduces the load on beams, columns, and foundations.

VIII) Structural Efficiency Analysis After construction, the system is evaluated based on: • Amount of water recycled • Reduction in concrete volume • Weight reduction of slab • Cost savings • Environmental benefits

4. Result

Table 1: Water Consumption

Slab Type	Water Consumption (Liters)	Water Saved
Traditional Slab	560 L	—
Bubble Deck Slab	280 L	280 L (50%)

Table 2: Concrete Usage

Slab Type	Concrete Usage (m^3)	Reduction
Traditional Slab	3.0 m^3	—
Bubble Deck Slab	2.1 m^3	0.9 m^3 ($\approx 30\%$)

Table 3: Weight Comparison

Slab Type	Weight (kg)	Weight Reduction
Traditional Slab	7200 kg	—
Bubble Deck Slab	5040 kg	2160 kg ($\approx 30\%$)

Table 4: Thermal Performance

Slab Type	Interior Temperature ($^{\circ}\text{C}$)	Temperature Reduction
Traditional Slab	28°C	0°C (Baseline)
Bubble Deck Slab	25°C	3°C

5. Conclusion

The integration of curing water recycling with Bubble Deck slab technology presents an innovative and sustainable approach to modern construction practices.

Traditional construction methods often lead to excessive consumption of water and materials, which increases both environmental impact and construction costs.

By introducing a system that collects and reuses curing water while incorporating Bubble Deck slabs, the project effectively addresses these challenges and promotes efficient resource utilization.

The results of the study demonstrate that the proposed system significantly reduces water consumption, concrete usage, and overall slab weight compared to conventional slab construction. The use of hollow plastic bubbles within the slab eliminates unnecessary concrete in the central portion without compromising structural strength.

Additionally, the water collection and recycling mechanism helps prevent wastage during the curing process, making the construction process more environmentally responsible. Another important benefit observed is the improvement in thermal performance.

The air gaps created by the hollow bubbles act as insulation, reducing heat transfer through the slab and helping maintain a lower indoor temperature.

This contributes to better indoor comfort and reduces the dependency on cooling systems, ultimately leading to lower energy consumption in buildings.

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